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AN ASSESSMENT OF THE DEARBORN RIVER WATERSHED: HABITAT AND AQUATIC INVERTEBRATE ASSEMBLAGES

July 2000

report prepared for

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Helena, Montana

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INTRODUCTION

Aquatic invertebrates are aptly applied to bioassessment since they are known to be important indicators of stream ecosystem health (Hynes 1970). Long lives, complex life cycles and limited mobility mean that there is ample time for the benthic community to respond to cumulative effects of environmental perturbations.

This report summarizes data collected in July 2000 from seven sites on Flat Creek and the South and Middle Forks of the Dearborn River, Lewis and Clark County, Montana. Aquatic invertebrate assemblages were sampled by personnel of the Montana Department of Environmental Quality (DEQ). Study sites lie within the Montana Valleys and Foothill Prairies ecoregion (Woods et al. 1999). A multimetric approach to bioassessment such as the one applied in this study uses attributes of the assemblage in an integrated way to measure biotic health. A stream with good biotic health is " ...a balanced, integrated, adaptive system having the full range of elements and processes that are expected in the region's natural environment..." (Karr and Chu 1999). The approach designed by Plafkin et al. (1989) and adapted for use in the State of Montana has been defined as "... an array of measures or metrics that individually provide information on diverse biological attributes, and when integrated, provide an overall indication of biological condition." (Barbour et al. 1995). Community attributes that can contribute meaningfully to interpretation of benthic data include assemblage structure, sensitivity of community members to stress or pollution, and functional traits. Each metric component contributes an independent measure of the biotic integrity of a stream site; combining the components into a total score reduces variance and increases precision of the assessment (Fore et al. 1995). Effectiveness of the integrated metrics depends on the applicability of the underlying model, which rests on a foundation of three essential elements (Bollman 1998). The first of these is an appropriate stratification or classification of stream sites, typically, by ecoregion. Second, metrics must be selected based upon their ability to accurately express biological condition. Third, an adequate assessment of habitat conditions at each site to be studied is needed to assist in the interpretation of metric outcomes.

Implicit in the multimetric method and its associated habitat assessment is an assumption of correlative relationships between habitat parameters and the biotic metrics, in the absence of water quality impairment. These relationships may vary regionally, requiring an examination of habitat assessment elements and biotic metrics and a test of the presumed relationship between them. Bollman (1998) has recently studied the assemblages of the Montana Valleys and Foothill Prairies ecoregion, and has recommended a battery of metrics specific to that ecoregion, which has been shown to be sensitive to impairment, related to habitat assessment parameters and consistent over replicated samples.

Habitat assessment enhances the interpretation of biological data (Barbour and Stribling 1991), because there is generally a direct response of the biological community to habitat degradation in the absence of water quality impairment. If biotic health appears more damaged than the habitat quality would predict, water pollution by metals, other toxicants, high water temperatures, or high levels of organic and/or nutrient pollution might be suspected. On the other hand, an "artificial" elevation of biotic condition in the presence of habitat degradation may be due to the paradoxical effect of mild nutrient or organic enrichment in an oligotrophic setting.

METHODS

Aquatic invertebrates were sampled at seven sites by Montana DEQ personnel from July 11-16, 2000. Sample identifications are given, sites are described, and locations indicated in Table 1. The sampling method employed was that recommended in the Montana Department of Environmental Quality (DEQ) Standard Operating Procedures for Aquatic Macroinvertebrate Sampling (Bukantis 1998). In addition to aquatic invertebrate sample collection, habitat quality was visually evaluated at each site and reported by means of the habitat assessment protocols recommended by Bukantis (1998) for streams with riffle/run prevalence.

Table 1. Sampling sites and dates. Tributaries of the Dearborn River. July 2000.

Site designation	Waterbody	Sampling date	Location description	GPS location
F-1	Flat Creek	7/13/00	Near headwaters	47°19'46"N 112°23'04"W
F-5	Flat Creek	7/12/00	On Dearborn Ranch, approx. ¾ mile upstream from Highway 27 crossing	47°18'29"N 112°08'04"W
F-7	Flat Creek	7/13/00	Below Birdtail Road crossing	47°15'05"N 112°03'48"W
MFD-2	Middle Fork Dearborn River	7/11/00	Above Highway 200 crossing	47°10'18"N 112°18'24"W
MFD-3	Middle Fork Dearborn River	7/11/00	Above Ingersoll's road crossing, approx. 5 miles above mouth	47°11'34"N 112°17'28"W
SFD-1	South Fork Dearborn River	7/11/00	Below Blacktail Cave	47°06'09"N 112°16'34"W
SFD-4	South Fork Dearborn River	7/16/00	Below Highway 434 crossing; a few miles upstream from mouth	47°09'44"N 112°13'06"W

Evaluated habitat features include instream conditions, larger-scale channel conditions including flow status, streambank condition, and extent of the riparian zone. Scores were assigned in the field to each habitat measure, and these scores were totaled and compared to the maximum possible score to give an overall assessment of habitat.

Aquatic invertebrate samples and associated habitat data were delivered to Rhithron Biological Associates, Missoula, Montana, for laboratory and data analyses.

In the laboratory, the Montana DEQ-recommended sorting method was used to obtain subsamples of at least 300 organisms from each sample, when possible. Organisms were identified to the lowest possible taxonomic levels consistent with Montana DEQ protocols.

To assess aquatic invertebrate communities in this study, a multimetric index developed in previous work for streams of western Montana ecoregions (Bollman 1998) was used. Multimetric indices result in a single numeric score, which integrates the values of several individual indicators of biologic health. Each metric used in this index was tested for its response or sensitivity to varying degrees of human influence. Correlations have been demonstrated between the metrics and various symptoms of human-caused impairment as expressed in water quality parameters or instream, streambank and stream reach morphologic features. Metrics were screened to minimize variability over natural environmental gradients, such as site elevation or sampling season, which might confound interpretation of results (Bollman 1998). The multimetric index used in this report incorporates multiple attributes of the sampled assemblage into an integrated score that accurately describes the benthic community of each site in terms of its biologic integrity. In addition to the metrics comprising the index, other metrics, which have been shown to be applicable to biomonitoring in other regions (Kleindl 1995, Patterson 1996, Rossano 1995) were used for descriptive interpretation of results. These metrics include the number of "clinger" taxa, long-lived taxa richness, the percent of predatory organisms, and others. They are not included in the integrated bioassessment score, however, since their performance in western Montana ecoregions is unknown. However, the relationship of these metrics to habitat conditions is intuitive and reasonable.

The six metrics comprising the bioassessment index used in this study were selected because both individually and as an integrated metric battery, they are robust at distinguishing impaired sites from relatively unimpaired sites (Bollman 1998). In addition, they are relevant to the kinds of impacts that are present in the Dearborn River watershed. They have been demonstrated to be more variable with anthropogenic disturbance than with natural environmental gradients (Bollman 1998). Each of the six metrics developed and tested for western Montana ecoregions is described below.

1. **Ephemeroptera (mayfly) taxa richness.** The number of mayfly taxa declines as water quality diminishes. Impairments to water quality which have been demonstrated to adversely affect the ability of mayflies to flourish include elevated water temperatures, heavy metal contamination, increased turbidity, low or high pH, elevated specific conductance and toxic chemicals. Few mayfly species are able to tolerate certain disturbances to instream habitat, such as excessive sediment deposition.
2. **Plecoptera (stonefly) taxa richness.** Stoneflies are particularly susceptible to impairments that affect a stream on a reach-level scale, such as loss of riparian canopy, streambank instability, channelization, and alteration of morphological features such as pool frequency and function, riffle development and sinuosity. Just as all benthic organisms, they are also susceptible to smaller scale habitat loss, such as by sediment deposition, loss of interstitial spaces between substrate particles, or unstable substrate.
3. **Trichoptera (caddisfly) taxa richness.** Caddisfly taxa richness has been shown to decline when sediment deposition affects their habitat. In addition, the presence of certain case-building caddisflies can indicate good retention of woody debris and lack of scouring flow conditions.
4. **Number of sensitive taxa.** Sensitive taxa are generally the first to disappear as anthropogenic disturbances increase. The list of sensitive taxa used here includes organisms sensitive to a wide range of disturbances, including warmer water temperatures, organic or

nutrient pollution, toxic pollution, sediment deposition, substrate instability and others. Unimpaired streams of western Montana typically support at least four sensitive taxa (Bollman 1998).

5. Percent filter feeders. Filter-feeding organisms are a diverse group; they capture small particles of organic matter, or organically enriched sediment material, from the water column by means of a variety of adaptations, such as silken nets or hairy appendages. In forested montane streams, filterers are expected to occur in insignificant numbers. Their abundance increases when canopy cover is lost and when water temperatures increase and the accompanying growth of filamentous algae occurs. Some filtering organisms, specifically the Arctopsychid caddisflies (*Arctopsyche* spp. and *Parapsyche* sp.) build silken nets with large mesh sizes that capture small organisms such as chironomids and early-instar mayflies. Here they are considered predators, and, in this study, their abundance does not contribute to the percent filter feeders metric.

6. Percent tolerant taxa. Tolerant taxa are ubiquitous in stream sites, but when disturbance increases, their abundance increases proportionately. The list of taxa used here includes organisms tolerant of a wide range of disturbances, including warmer water temperatures, organic or nutrient pollution, toxic pollution, sediment deposition, substrate instability and others.

Scoring criteria for each of the six metrics are presented in Table 2. Metrics differ in their possible value ranges as well as in the direction the values move as biological conditions change. For example, Ephemeroptera richness values may range from zero to ten taxa or higher. Larger values generally indicate favorable biotic conditions. On the other hand, the percent filterers metric may range from 0% to 100%; in this case, larger values are negative indicators of biotic health. To facilitate scoring, therefore, metric values were transformed into a single scale. The range of each metric has been divided into four parts and assigned a point score between zero and three. A score of three indicates a metric value similar to one characteristic of a non-impaired condition. A score of zero indicates strong deviation from non-impaired condition and suggests severe degradation of biotic health. Scores for each metric were summed to give an overall score, the total bioassessment score, for each site in each sampling event. These scores were expressed as the percent of the maximum possible score, which is 18 for this metric battery.

The total bioassessment score for each site was expressed in terms of use-support. Criteria for use-support designations were developed by Montana DEQ and are presented in Table 3a. Scores were also translated into impairment classifications according to criteria outlined in Table 3a.

In this report, certain other metrics were used as descriptors of the benthic community response to habitat or water quality but were not incorporated into the bioassessment metric battery, either because they have not yet been tested for reliability in streams of western Montana, or because results of such testing did not show them to be robust at distinguishing impairment, or because they did not meet other requirements for inclusion in the metric battery. These metrics and their use in predicting the causes of impairment or in describing its effects on the biotic community are described below.

Table 2. Metrics and scoring criteria for bioassessment of streams of western Montana ecoregions (Bollman 1998).

	Score			
metric	**3**	**2**	**1**	**0**
Ephemeroptera taxa richness	> 5	5 - 4	3 – 2	< 2
Plecoptera taxa richness	> 3	3 - 2	1	0
Trichoptera taxa richness	> 4	4 - 3	2	< 2
Sensitive taxa richness	> 3	3 - 2	1	0
Percent filterers	0 – 5	5.01 - 10	10.01 – 25	> 25
Percent tolerant taxa	0 – 5	5.01 - 10	10.01 – 35	> 35

- The modified biotic index. This metric is an adaptation of the Hilsenhoff Biotic Index (HBI, Hilsenhoff 1987), which was originally designed to indicate organic enrichment of waters. Values of this metric are lowest in least impacted conditions. Taxa tolerant to saprobic conditions are also generally tolerant of warm water, fine sediment and heavy filamentous algae growth (Bollman, unpublished data). Loss of canopy cover is often a contributor to higher biotic index values. The taxa values used in this report are modified to reflect habitat and water quality conditions in Montana (Bukantis 1998). Ordination studies of the benthic fauna of Montana's foothill prairie streams showed that there is a correlation between modified biotic index values and water temperature, substrate embeddedness, and fine sediment (Bollman 1998). In a study of reference streams, the average value of the modified biotic index in least-impaired streams of western Montana was 2.5 (Wisseman 1992).
- Taxa richness. This metric is a simple count of the number of unique taxa present in a sample. Average taxa richness in samples from reference streams in western Montana was 28 (Wisseman 1992). Taxa richness is an expression of biodiversity, and generally decreases with degraded habitat or diminished water quality. However, taxa richness may show a paradoxical increase when mild nutrient enrichment occurs in previously oligotrophic waters, so this metric must be interpreted with caution.
- Percent predators. Aquatic invertebrate predators depend on a reliable source of invertebrate prey, and their abundance provides a measure of the trophic complexity supported by a site. Less disturbed sites have more plentiful habitat niches to support diverse prey species, which in turn support abundant predator species.
- Number of "clinger" taxa. So-called "clinger" taxa have physical adaptations that allow them to cling to smooth substrates in rapidly flowing water. Aquatic invertebrate "clingers" are sensitive to fine sediments that fill interstices between substrate particles and eliminate habitat complexity. Animals that occupy the hyporheic zones are included in this group of taxa. Expected "clinger" taxa richness in unimpaired streams of western Montana is at least 14 (Bollman, unpublished data).
- Number of long-lived taxa. Long-lived or semivoltine taxa require more than a year to completely develop, and their numbers decline when habitat and/or water quality conditions are unstable. They may completely disappear if channels are dewatered or if there are periodic water temperature elevations or other interruptions to their life cycles.

Table 5. Metric values, scores, and bioassessments for sites on tributaries of the Dearborn River, July 2000. Sites are described in Table 1. The assessment classification and use support designation for site SFD-1 is in parentheses to indicate that these results are tentative. The sample from this location had an inadequate number of organisms for meaningful interpretation.

	SITES						
	F-1	F-5	F-7	MFD-2	MFD-3	SFD-1	SFD-4
METRICS	**METRIC VALUES**						
Ephemeroptera richness	3	4	4	7	5	4	3
Plecoptera richness	1	2	0	1	2	2	4
Trichoptera richness	4	4	3	9	4	8	4
Number of sensitive taxa	1	0	0	0	0	2	0
Percent filterers	5	21	30	9	1	0	1
Percent tolerant taxa	14	41	59	22	30	8	59
	METRIC SCORES						
Ephemeroptera richness	1	2	2	3	2	2	1
Plecoptera richness	1	2	0	1	2	2	3
Trichoptera richness	2	2	2	3	2	3	2
Number of sensitive taxa	1	0	0	0	0	2	0
Percent filterers	3	1	0	2	3	3	3
Percent tolerant taxa	1	0	0	1	1	2	0
TOTAL SCORE (max.=18)	9	7	4	10	10	14	9
PERCENT OF MAX.	**50**	**39**	**22**	**56**	**56**	**(78)**	**50**
Impairment classification*	**MOD**	**MOD**	**SEV**	**SLI**	**SLI**	**(SLI)**	**MOD**
USE SUPPORT †	**PART**	**PART**	**NON**	**PART**	**PART**	**(FULL)**	**PART**

*Impairment classifications: (NON) non-impaired, (SLI) slightly impaired, (MOD) moderately impaired, (SEV) severely impaired. See Table 3a.
† Use support designations: See Table 3b.

most tolerant of the local perlids. While a dearth of stonefly taxa may suggest reach scale habitat disturbance, it may also be the result of poor water quality. Thirteen "clinger" taxa were present in the sample, indicating that hard substrate surfaces were essentially unimpacted by fine sediment deposition. Uninterrupted year-round flow in this reach seems to be indicated by the presence of 6 long-lived taxa.

Evidence of water quality degradation is less apparent in the data generated from the assemblage collected at the intermediate Flat Creek site (F-5). The modified biotic index value (4.58) calculated for the sampled organisms is within expected limits for a foothill prairie site. Filter-feeders, including the caddisfly *Hydropsyche* sp. and the midge *Rheotanytarsus* sp., were abundant here, comprising 21% of sampled organisms; this suggests that fine organic material in suspension was plentiful. Taxa richness was low, and the number of predator taxa was also depressed, suggesting that some factor limited the diversity of habitats. The low abundance of scrapers among the functional components suggests that the augmented flows and turbidity

Table 4. Stream and riparian habitat assessment. Tributaries of the Dearborn River. July 2000.

Max. possible score	Parameter	F-1	F-5	F-7	MFD-2	MFD-3	SFD-1	SFD-4
10	Riffle development	10	7	9	9	9	8	10
10	Benthic substrate	10	6	6	10	6	8	7
20	Embeddedness	18	15	11	19	15	18	18
20	Channel alteration	18	15	15	10	15	20	13
20	Sediment deposition	19	10	12	19	8	19	16
20	Channel flow status	20	20	20	15	15	15	11
20	Bank stability	9 / 9	5 / 5	3 / 3	10 / 10	10 / 10	10 / 10	6 / 6
20	Bank vegetation	9 / 9	2 / 1	5 / 5	10 / 2	9 / 9	9 / 9	7 / 7
20	Vegetated zone	7 / 4	3 / 1	2 / 2	8 / 3	10 / 10	8 / 5	6 / 6
160	Total	141	90	93	125	126	139	113
	Percent of maximum	**88**	**56**	**58**	**78**	**79**	**87**	**71**
	CONDITION*	**OPT**	**SUB**	**SUB**	**OPT**	**OPT**	**OPT**	**SUB**

*Condition categories: Optimal (OPT) > 80% of maximum score; Sub-optimal (SUB) ; 75 - 56%: Marginal (MARG) 49 - 29%; Poor <23%. Adapted from Plafkin et al. 1998

Western Montana streams with stable habitat conditions are expected to support six or more long-lived taxa (Bollman, unpublished data).

Table 3a. Criteria for the assignment of use-support classifications / standards violation thresholds (Bukantis, 1997).	
% Comparability to reference	Use support
>75	Full support--standards not violated
25-75	Partial support--moderate impairment--standards violated
<25	Non-support--severe impairment--standards violated

Table 3b. Criteria for the assignment of impairment classifications (Plafkin et al. 1989).	
% Comparability to reference	Classification
> 83	nonimpaired
54-79	slightly impaired
21-50	moderately impaired
<17	severely impaired

RESULTS

Habitat assessment

Figure 1 compares habitat assessment results for the 7 sites visited. Table 4 itemizes the evaluated habitat parameters and shows the assigned scores for each.

Figure 1. Total habitat assessment scores for tributaries of the Dearborn River. July 2000.

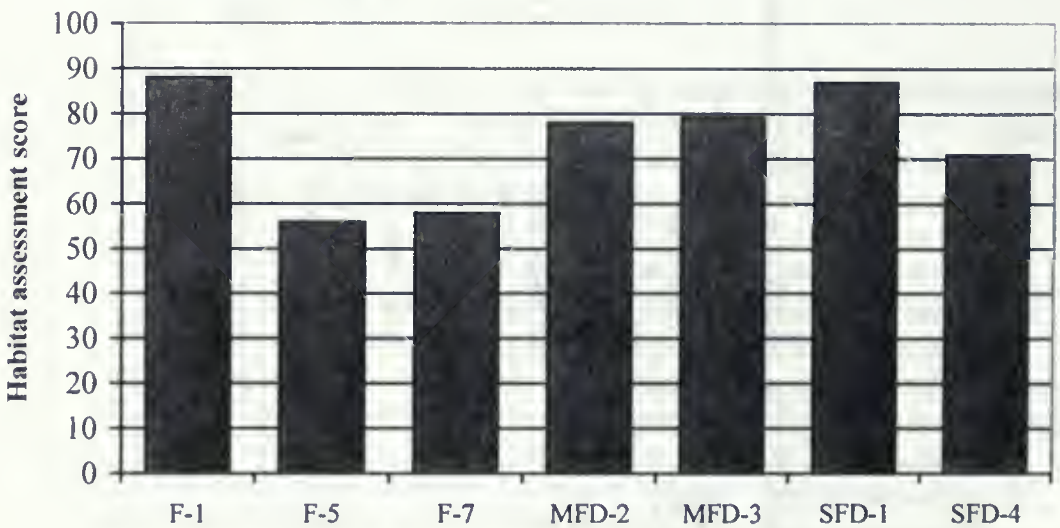
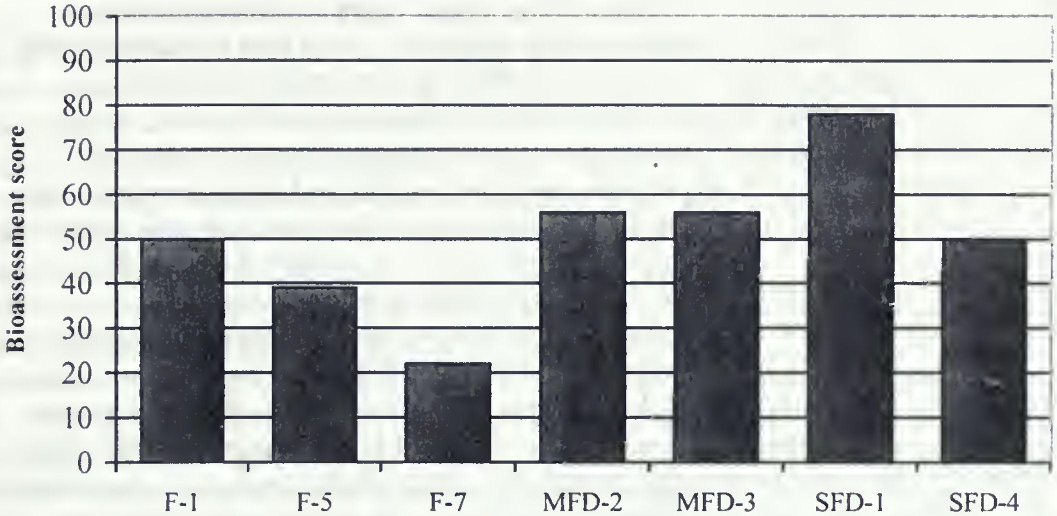


Figure 2. Total bioassessment scores for seven sites on tributaries of the Dearborn River. July 2000. Sites are described in Table 1.



were collected there. Tolerant taxa abundance was greater than expected at the site.

Bioassessment scores for Flat Creek sites worsen in a downstream direction. The two upstream sites (F-1 and F-5) exhibited moderate impairment and partly supported uses. The upper site apparently supported fewer Ephemeroptera and Plecoptera taxa than expected, and Trichoptera taxa richness was also somewhat depressed. The abundance of tolerant taxa was greater than expected. The intermediate site on Flat Creek (F-5) yielded fewer taxa in all three insect orders than expected, and no sensitive taxa were collected at the site. In addition, both filter-feeders and tolerant taxa comprised greater proportions of the sample than expected. The downstream site on Flat Creek (F-7) received the lowest bioassessment score among the sites visited, and appeared to be severely impaired. Scores indicate that the site did not support designated uses. No Plecoptera were collected at the site, and sensitive taxa were also absent from the sample. Ephemeroptera and Trichoptera taxa richnesses were less than expected. Both filter-feeders and tolerant taxa exceeded expected abundances.

Aquatic invertebrate communities

Midges overwhelmed the sample collected at the uppermost site on Flat Creek (F-1), comprising 72% of the organisms taken there. Only 3 mayfly taxa were present, and none of these occurred in abundance at the site. The modified biotic index value (5.11) calculated for the assemblage was elevated. These findings suggest that poor water quality at this site may limit the integrity of the benthic community. Impairment may be due to nutrients and/or organic inputs. The functional components of the assemblage appear to be unbalanced toward a preponderance of gathering detritivores, which lends support to the hypothesis of water quality degradation. Only a single taxon of stonefly was collected at the site; this was *Hesperoperla pacifica*, the

Habitat was judged optimal at the uppermost site on Flat Creek (F-1), but conditions were perceived to deteriorate to sub-optimal downstream. At the intermediate site (F-5), moderate sediment deposition was predicted, since streambanks were observed to be actively sloughing; however, high flows prohibited an adequate assessment. Bank vegetative protection was appraised as poor, and the riparian zone width was abbreviated on both banks at the sampling site. Conditions were judged only slightly better at the most downstream site (F-7), where turbidity again precluded an adequate assessment of sediment deposition. However, active slumping and sloughing of streambanks were noted; banks were appraised as moderately unstable. Bank vegetative protection was rated as marginal, but the field evaluator noted that some recovery from historic grazing appeared to be in progress. The riparian zone width in this reach was perceived to be poor. At both lower sites on Flat Creek, irrigation returns from Dearborn River diversions augmented flow, which was judged unnaturally high.

Both sites on the Middle Fork Dearborn River exhibited near-optimal habitat conditions. In contrast to the flow conditions at the lower sites on Flat Creek, Middle Fork flows were low, reflecting the droughty conditions of 2000. At the upper site (MFD-2), rip-rap altered channel was noted; as a result, bank vegetative protection was perceived to be poor on one side of the reach. Riparian zone width was also marginal on that side. At the downstream site, considerable deposition of silty sediment in pools and riffles lowered the overall habitat assessment score. Fencing excluded cattle from streambanks on both sides of this reach.

Habitat at the upstream site on the South Fork Dearborn River was judged optimal. The riparian zone width was perceived to be marginal on one side of the channel due to bedrock confinement. Otherwise, notes and scores suggested that disturbance in this reach was minimal. The downstream site on this tributary was located below a road crossing, which appeared to be the source of fine sediments deposited above and at the sampled site. In addition, localized bank erosion was noted. Low flow conditions were noted at both sites on the South Fork Dearborn River.

Bioassessment

Figure 2 summarizes bioassessment scores for aquatic invertebrate communities at the 7 sites in this study. Table 5 itemizes each contributing metric and shows individual metric scores for each site. Tables 3a and 3b show criteria for impairment classifications and use-support categories recommended by Montana DEQ.

When this bioassessment method is applied to the aquatic invertebrate data generated in this study, both sites on the Middle Fork Dearborn River appear to be slightly impaired and partially supportive of designated uses. At the upper site (MFD-2), Plecoptera taxa richness was lower than expected, and no sensitive taxa were collected. The abundances of both filter-feeders and tolerant taxa were higher than expected. At the downstream site (MFD-3), all 3 insect richness metrics performed somewhat worse than expected, and the proportion of tolerant taxa exceeded expectations. In addition, no sensitive taxa were collected at the site.

Low invertebrate abundance in the sample collected at the upstream site on the South Fork Dearborn River (SFD-1) prevents meaningful interpretation of results; thus, the classification of slight impairment and full support of uses is tentative, as indicated in Table 5. Downstream, site SFD-4 yielded fewer Ephemeroptera taxa than expected, and no sensitive taxa

reported by field personnel may have limited available habitats. Disturbingly, only 2 long-lived taxa were collected in the sample, suggesting the possibility that surface flow may fall precipitously when irrigation returns do not augment the natural flow regime.

Severe impairment of biotic health at the lowest studied site on Flat Creek (F-7) may be due to a combination of poor water quality and habitat disturbance. The high modified biotic index value (5.85) could be attributed to nutrient and/or organic enrichment, elevated water temperatures, or both. There are some indications of both conditions in the taxonomic composition of the sampled invertebrate assemblage. Many tolerant taxa, among them leeches (*Erpobdella* sp.), snails (physids and *Gyraulus* sp.), and scuds (*Hyalella azteca*) were abundant in the sample. All of these animals tolerate both saprobity and warm water. The presence of hemoglobin-bearing midges, such as *Chironomus* sp. and *Cryptochironomus* sp. suggests that benthic sediments may be anoxic, a condition that develops in nutrient-enriched and/or warm water. Habitat disturbance is suggested by the presence of sediment-tolerant organisms such as *Dubiraphia* sp. and *Tricorythodes minutus*; further, only 9 "clinger" taxa and 3 caddisfly taxa were collected. Fine sediment deposition may compromise habitats at this site. The large proportion of filter-feeders among the functional components of the assemblage suggests that fine particulate organic material in suspension is abundant. Scrapers are not very well represented at this site, and midges are curiously uncommon in the sample. These findings may be the result of augmented flows and turbid water. Similar to site F-5, this site also yielded only 2 long-lived taxa, suggesting that surface flows may be lost altogether seasonally, or that other catastrophic interferences with life cycles may periodically occur at these sites.

The modified biotic index score (3.60) calculated for the assemblage from the upper site on the Middle Fork Dearborn River (MFD-2) suggests that water quality was essentially unimpaired at this site. Seven mayfly taxa occurred here, strengthening the hypothesis. The 9 caddisfly taxa and 19 "clinger" taxa that were collected imply that fine sediment deposition did not limit benthic habitats at this site. The taxa richness (32) was high, and 6 predator taxa were taken in the sample. These findings suggest that instream habitats were diverse and plentiful. Only a few stoneflies in the single taxon *Hesperoperla pacifica* were collected, suggesting that reach scale disturbances may be a limitation to biotic integrity here. However, all functional components of a healthy biotic community were represented in the sampled assemblage, suggesting that impairment to biotic health was slight.

At the downstream site on the Middle Fork Dearborn River (MFD-3), fewer caddisfly taxa and fewer "clinger" taxa than at site MFD-2 raise the possibility that more fine sediment deposition occurred here than at the upstream site. The dominant organism in the sample was the midge *Polypedilum* sp., which prefers fine sediments. This beast comprised 22% of the assemblage. Still, taxa richness (30) and the number of predator taxa (5) present at the site suggest that diverse habitats were available; thus, the effect on biotic health of fine sediments was probably mild. Indicators of water quality impairment, including the modified biotic index and the number of mayfly taxa, gave signals suggesting that biotic health is not substantially affected by nutrient enrichment or elevated temperature.

Only 91 organisms were present in the sample taken at the upstream site on the South Fork Dearborn River (SFD-1). Whether these numbers actually represent a paucity of benthic biota at the site or whether they are a result of sampling bias cannot be discerned. Only a few observations based on the bioassessment results can be reasonably made. In spite of the low

abundance of animals, 27 taxa were collected. This suggests that instream habitats were essentially intact. Eight caddisfly taxa and 12 "clinger" taxa were included in the assemblage, suggesting that fine sediment deposition did not limit benthic habitats. Two sensitive taxa were present in the sample: the caddisfly *Ecclisomyia* sp. and the midge *Cricotopus nostococladius*. This evidence, along with the presence of 4 mayfly taxa in the sample, suggests that water quality was probably relatively unimpaired.

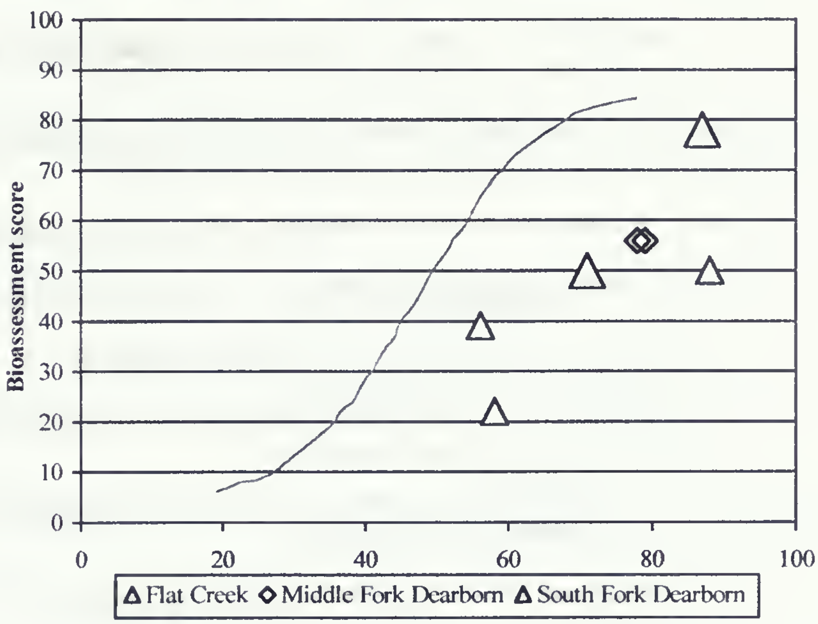
In spite of a relatively low modified biotic index value (3.47), there is evidence for mild nutrient enrichment at the lower site on the South Fork Dearborn River (SFD-4). Only 3 mayfly taxa were present in the sample, and none were abundant. The tolerant snail *Fossaria* sp. was abundant, and physid snails were present. Functional composition of the assemblage appeared to be skewed toward scrapers, which comprised 48% of animals collected. This high proportion of scrapers suggests that algal films were the main energy source for secondary producers at the site, implying that nutrients are abundantly available. Thirteen "clinger" taxa were present in the sample, suggesting that fine sediment deposition did not limit benthic habitats. Four stonefly taxa were collected; among these were 2 chloroperlids: *Sweltsa* sp. and *Suwallia* sp. Ample stonefly taxa suggests that large scale disturbances were minimal. The chloroperlid stoneflies typically inhabit interstitial habitats, and their presence gives further strength to the hypothesis that fine sediments were not obliterating these niches.

CONCLUSIONS

- Mild water quality impairment, perhaps by nutrient enrichment, may limit biotic health at the upstream site on Flat Creek (F-1)
- At the intermediate and lower sites on Flat Creek (F-5 and F-7) augmented flows from irrigation returns and turbidity, both noted by field personnel, may alter benthic communities. Biotic health may be further impacted by seasonal low flows.
- At the downstream site on Flat Creek (F-7), water quality degradation, perhaps by nutrient and/or organic enrichment, elevated water temperatures, or both, combined with habitat disturbances to result in severe impairment of biotic health. Habitat disturbances appear to include excessive fine sediment deposition.
- Good water quality is suggested by the composition of the benthic assemblage at the upstream site on the Middle Fork Dearborn River (MFD-2). Slight impairment of biotic integrity may be due to reach scale problems, such as channel alteration or loss of riparian zone function.
- At the downstream site on the Middle Fork Dearborn River (MFD-3), slightly increased fine sediment deposition appears to limit benthic biota. Good water quality is suggested by the taxonomic composition of the assemblage.
- Low abundance of organisms in the sample taken at the upstream site on the South Fork Dearborn River (SFD-1) prohibits complete analysis, but sediment deposition does not appear to limit biotic health at the site.
- Mild water quality degradation, perhaps by nutrient enrichment, appears to affect biotic health to some degree at the lower site on the South Fork (SFD-4).
- The relationship between habitat assessment scores and bioassessment scores is illustrated in Figure 3. The red curve in the center of the graph represents the hypothetical

relationship between habitat quality and biotic health when habitat degradation is the sole source of impairment to benthic assemblage health (Barbour and Stribling 1991). Symbols that fall below the line indicate that bioassessment scores are somewhat lower than would be expected if impairment were due to habitat degradation alone and suggest that water quality impairment, perhaps by elevated temperatures or elevated nutrient concentrations, was the predominant factor limiting biotic health in these streams.

Figure 3. The relationship of habitat assessment scores and bioassessment scores for sites on tributaries of the Dearborn River, July 2000. The red curve represents the hypothetical relationship between habitat scores and bioassessment scores if habitat quality solely determined biotic health.



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APPENDIX

Taxonomic data and summaries

Tributaries of the Dearborn River

July-2000

Aquatic Invertebrate Taxonomic Data

Site Name: Flat Creek

Site ID: F-1 7/13/2000 Approx. percent of sample used: 77

Taxon	Quantity	Percent	HBI	FFG
Nematoda	1	0.33	5	PA
Limnodrilus hoffmeisteri	2	0.66	9	CG
Fossaria sp.	2	0.66	6	CG
Hyalella azteca	1	0.33	8	CG
Total Misc. Taxa	**6**	**1.97**		
Baetis tricaudatus	4	1.32	6	CG
Drunella coloradensis	1	0.33	0	CG
Ephemerella sp.	11	3.62	1	CG
Total Ephemeroptera	**16**	**5.26**		
Hesperoperla pacifica	14	4.61	2	PR
Total Plecoptera	**14**	**4.61**		
Amiocentrus aspilus	3	0.99	3	CG
Brachycentrus americanus	10	3.29	1	OM
Brachycentrus occidentalis	3	0.99	1	OM
Rhyacophila Angelita Gr.	2	0.66	0	PR
Total Trichoptera	**18**	**5.92**		
Cleptelmis sp.	10	3.29	4	CG
Optioservus sp.	5	1.64	4	SC
Zaitzevia sp.	1	0.33	4	CG
Total Coleoptera	**16**	**5.26**		
Chelifera sp.	1	0.33	6	PR
Simulium sp.	13	4.28	6	CF
Tanyderidae	1	0.33	1	UN
Total Diptera	**15**	**4.93**		
Cricotopus nostococladius	2	0.66	3	PH
Cricotopus Trifascia Gr.	17	5.59	6	CG
Eukiefferiella Devonica Gr.	25	8.22	4	OM
Eukiefferiella Gracei Gr.	8	2.63	4	OM
Eukiefferiella Pseudomontana Gr.	20	6.58	8	OM
Orthocladius sp.	142	46.71	6	CG
Pagastia sp.	1	0.33	1	CG
Polypedilum sp.	1	0.33	6	OM
Rheotanytarsus sp.	1	0.33	6	CF
Tvetenia sp.	2	0.66	5	CG
Total Chironomidae	**219**	**72.04**		
Grand Total	**304**	**100.00**		

Aquatic Invertebrate Summary Data

Site Name: Flat Creek **Site ID: F-1 7/13/2000**

TOTAL ABUNDANCE	304
Ephemeroptera + Plecoptera + Trichoptera (EPT) abundance	48
TOTAL NUMBER OF TAXA	28
Number EPT taxa	8

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Misc. Taxa	4	6	1.97
Odonata	0	0	0.00
Ephemeroptera	3	16	5.26
Plecoptera	1	14	4.61
Hemiptera	0	0	0.00
Megaloptera	0	0	0.00
Trichoptera	4	18	5.92
Lepidoptera	0	0	0.00
Coleoptera	3	16	5.26
Diptera	3	15	4.93
Chironomidae	10	219	72.04

RATIOS OF TAX GROUP ABUNDANCES

EPT/Chironomidae	0.22

FUNCTIONAL FEEDING GROUP (FFG) COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Predator	3	17	5.59
Parasite	1	1	0.33
Collector-gatherer	13	197	64.80
Collector-filterer	2	14	4.61
Macrophyte-herbivore	0	0	0.00
Piercer-herbivore	1	2	0.66
Scraper	1	5	1.64
Shredder	0	0	0.00
Xylophage	0	0	0.00
Omnivore	6	67	22.04
Unknown	1	1	0.33

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filterer	0.36
Scraper/(Scraper + C.filterer)	0.26
Shredder/Total organisms	0.00

CONTRIBUTION OF DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Orthocladius sp.	142	46.71
Eukiefferiella Devonica Gr.	25	8.22
Eukiefferiella Pseudomontana (	20	6.58
Cricotopus Trifascia Gr.	17	5.59
Hesperoperla pacifica	14	4.61
SUBTOTAL 5 DOMINANTS	218	71.71
Simulium sp.	13	4.28
Ephemerella sp.	11	3.62
Brachycentrus americanus	10	3.29
Cleptelmis sp.	10	3.29
Eukiefferiella Gracei Group	8	2.63
TOTAL DOMINANTS	270	88.81

SAPROBIC INDICES

Hilsenhoff Biotic Index	5.11

DIVERSITY MEASURES

Shannon H (loge)	1.81
Shannon H (log2)	2.61
Evenness	0.54
Simpson D	0.20

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	168	55.35
Univoltine	92	30.18
Semivoltine	44	14.47

	#TAXA	ABUNDANCE	PERCENT
Tolerant	7	43	14.14
Intolerant	2	3	0.99
Clinger	13	78	25.66

Aquatic Invertebrate Taxonomic Data

Site Name: Flat Creek
Site ID: F-5 7/12/2000

Approx. percent of sample used: 13

Taxon	Quantity	Percent	HBI	FFG
Tubificidae - immature	2	0.60	9	CG
Sphaeriidae	1	0.30	8	CG
Physidae	3	0.91	8	CG
Gammarus sp.	6	1.81	6	CG
Total Misc. Taxa	**12**	**3.63**		
Baetis tricaudatus	108	32.63	6	CG
Nixe sp.	2	0.60	2	SC
Paraleptophlebia sp.	1	0.30	4	CG
Tricorythodes minutus	5	1.51	4	CG
Total Ephemeroptera	**116**	**35.05**		
Zapada cinctipes	1	0.30	2	SH
Perlodidae-early instar	3	0.91	2	PR
Total Plecoptera	**4**	**1.21**		
Brachycentrus occidentalis	75	22.66	1	OM
Hydropsyche sp.	23	6.95	4	CF
Mayatrichia sp.	2	0.60	6	SC
Ochrotrichia sp.	1	0.30	4	PH
Total Trichoptera	**101**	**30.51**		
Optioservus sp.	12	3.63	4	SC
Total Coleoptera	**12**	**3.63**		
Simulium sp.	11	3.32	6	CF
Total Diptera	**11**	**3.32**		
Cricotopus Trifascia Gr.	20	6.04	6	CG
Eukiefferiella Pseudomontana Gr.	1	0.30	8	OM
Polypedilum sp.	14	4.23	6	OM
Rheotanytarsus sp.	36	10.88	6	CF
Thienemannimyia Gr.	2	0.60	6	PR
Tvetenia sp.	2	0.60	5	CG
Total Chironomidae	**75**	**22.66**		
Grand Total	**331**	**100.00**		

Aquatic Invertebrate Summary Data

Site Name: Flat Creek **Site ID: F-5 7/12/2000**

TOTAL ABUNDANCE	331
Ephemeroptera + Plecoptera + Trichoptera (EPT) abundance	221
TOTAL NUMBER OF TAXA	22
Number EPT taxa	10

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Misc. Taxa	4	12	3.63
Odonata	0	0	0.00
Ephemeroptera	4	116	35.05
Plecoptera	2	4	1.21
Hemiptera	0	0	0.00
Megaloptera	0	0	0.00
Trichoptera	4	101	30.51
Lepidoptera	0	0	0.00
Coleoptera	1	12	3.63
Diptera	1	11	3.32
Chironomidae	6	75	22.66

RATIOS OF TAX GROUP ABUNDANCES

EPT/Chironomidae	2.95

FUNCTIONAL FEEDING GROUP (FFG) COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Predator	2	5	1.51
Parasite	0	0	0.00
Collector-gatherer	9	148	44.71
Collector-filterer	3	70	21.15
Macrophyte-herbivore	0	0	0.00
Piercer-herbivore	1	1	0.30
Scraper	3	16	4.83
Shredder	1	1	0.30
Xylophage	0	0	0.00
Omnivore	3	90	27.19
Unknown	0	0	0.00

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filterer	0.23
Scraper/(Scraper + C.filterer)	0.19
Shredder/Total organisms	0.00

CONTRIBUTION OF DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Baetis tricaudatus	108	32.63
Brachycentrus occidentalis	75	22.66
Rheotanytarsus sp.	36	10.88
Hydropsyche sp.	23	6.95
Cricotopus Trifascia Gr.	20	6.04
SUBTOTAL 5 DOMINANTS	262	79.15
Polypedilum sp.	14	4.23
Optioservus sp.	12	3.63
Simulium sp.	11	3.32
Gammarus sp.	6	1.81
Tricorythodes minutus	5	1.51
TOTAL DOMINANTS	305	92.15

SAPROBIC INDICES

Hilsenhoff Biotic Index	4.58

DIVERSITY MEASURES

Shannon H (loge)	1.77
Shannon H (log2)	2.55
Evenness	0.57
Simpson D	0.15

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	145	43.88
Univoltine	98	29.68
Semivoltine	88	26.44

	#TAXA	ABUNDANCE	PERCENT
Tolerant	7	136	41.09
Intolerant	0	0	0.00
Clinger	10	196	59.21

Aquatic Invertebrate Taxonomic Data

Site Name: Flat Creek
Site ID: F-7 7/13/2000

Approx. percent of sample used: 12

Taxon	**Quantity**	**Percent**	**HBI**	**FFG**
Erpobdellidae	1	0.30	10	PR
Sphaeriidae	1	0.30	8	CG
Physidae	13	3.89	8	CG
Gyraulus sp.	2	0.60	8	SC
Hyalella azteca	31	9.28	8	CG
Acari	3	0.90	5	PA
Total Misc. Taxa	**51**	**15.27**		
Labiobaetis sp.	7	2.10	4	CG
Baetis tricaudatus	85	25.45	6	CG
Paraleptophlebia sp.	2	0.60	4	CG
Tricorythodes minutus	37	11.08	4	CG
Total Ephemeroptera	**131**	**39.22**		
Hydropsyche sp.	8	2.40	4	CF
Mayatrichia sp.	6	1.80	6	SC
Ochrotrichia sp.	3	0.90	4	PH
Total Trichoptera	**17**	**5.09**		
Dubiraphia sp.	1	0.30	6	CG
Optioservus sp.	21	6.29	4	SC
Total Coleoptera	**22**	**6.59**		
Simulium sp.	89	26.65	6	CF
Total Diptera	**89**	**26.65**		
Chironomus sp.	2	0.60	10	CG
Cricotopus Trifascia Gr.	10	2.99	6	CG
Cryptochironomus sp.	1	0.30	8	PR
Orthocladius sp.	1	0.30	6	CG
Polypedilum sp.	2	0.60	6	OM
Rheotanytarsus sp.	4	1.20	6	CF
Thienemannimyia Gr.	4	1.20	6	PR
Total Chironomidae	**24**	**7.19**		
Grand Total	**334**	**100.00**		

Aquatic Invertebrate Summary Data

Site Name: Flat Creek **Site ID: F-7 7/13/2000**

TOTAL ABUNDANCE	334
Ephemeroptera + Plecoptera + Trichoptera (EPT) abundance	148
TOTAL NUMBER OF TAXA	23
Number EPT taxa	7

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Misc. Taxa	6	51	15.27
Odonata	0	0	0.00
Ephemeroptera	4	131	39.22
Plecoptera	0	0	0.00
Hemiptera	0	0	0.00
Megaloptera	0	0	0.00
Trichoptera	3	17	5.09
Lepidoptera	0	0	0.00
Coleoptera	2	22	6.59
Diptera	1	89	26.65
Chironomidae	7	24	7.19

RATIOS OF TAX GROUP ABUNDANCES

EPT/Chironomidae	6.17

FUNCTIONAL FEEDING GROUP (FFG) COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Predator	3	6	1.80
Parasite	1	3	0.90
Collector-gatherer	11	190	56.89
Collector-filterer	3	101	30.24
Macrophyte-herbivore	0	0	0.00
Piercer-herbivore	1	3	0.90
Scraper	3	29	8.68
Shredder	0	0	0.00
Xylophage	0	0	0.00
Omnivore	1	2	0.60
Unknown	0	0	0.00

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filterer	0.29
Scraper/(Scraper + C.filterer)	0.22
Shredder/Total organisms	0.00

CONTRIBUTION OF DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Simulium sp.	89	26.65
Baetis tricaudatus	85	25.45
Tricorythodes minutus	37	11.08
Hyalella azteca	31	9.28
Optioservus sp.	21	6.29
SUBTOTAL 5 DOMINANTS	263	78.74
Physidae	13	3.89
Cricotopus Trifascia Gr.	10	2.99
Hydropsyche sp.	8	2.40
Labiobaetis sp.	7	2.10
Mayatrichia sp.	6	1.80
TOTAL DOMINANTS	307	91.92

SAPROBIC INDICES

Hilsenhoff Biotic Index	5.85

DIVERSITY MEASURES

Shannon H (loge)	2.21
Shannon H (log2)	3.19
Evenness	0.71
Simpson D	0.16

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	99	29.57
Univoltine	213	63.70
Semivoltine	23	6.74

	#TAXA	ABUNDANCE	PERCENT
Tolerant	10	196	58.68
Intolerant	0	0	0.00
Clinger	9	144	43.11

Aquatic Invertebrate Taxonomic Data

Site Name: Middle Fork Dearborn River

Site ID: MFD-2 7/11/2000

Approx. percent of sample used: 20

Taxon	Quantity	Percent	HBI	FFG
Polycelis coronata	1	0.33	4	CG
Acari	2	0.67	5	PA
Total Misc. Taxa	**3**	**1.00**		
Baetis tricaudatus	3	1.00	6	CG
Diphetor hageni	1	0.33	5	CG
Drunella coloradensis	3	1.00	0	CG
Ephemerella sp.	2	0.67	1	CG
Serratella tibialis	2	0.67	2	CG
Cinygmula sp.	3	1.00	4	SC
Epeorus albertae	3	1.00	1	SC
Total Ephemeroptera	**17**	**5.69**		
Hesperoperla pacifica	4	1.34	2	PR
Total Plecoptera	**4**	**1.34**		
Amiocentrus aspilus	1	0.33	3	CG
Brachycentrus americanus	21	7.02	1	OM
Agapetus sp.	2	0.67	0	SC
Glossosoma sp.	6	2.01	1	SC
Hydropsyche sp.	27	9.03	4	CF
Ochrotrichia sp.	34	11.37	4	PH
Lepidostoma sp.-turret case larvae	4	1.34	2	SH
Rhyacophila Angelita Gr.	1	0.33	0	PR
Neophylax rickeri	7	2.34	2	SC
Total Trichoptera	**103**	**34.45**		
Optioservus sp.	14	4.68	4	SC
Zaitzevia sp.	14	4.68	4	CG
Total Coleoptera	**28**	**9.36**		
Chelifera sp.	1	0.33	6	PR
Clinocera sp.	1	0.33	6	PR
Simulium sp.	1	0.33	6	CF
Tabanidae	1	0.33	8	PR
Antocha sp.	15	5.02	3	CG
Total Diptera	**19**	**6.35**		
Eukiefferiella Gracei Gr.	21	7.02	4	OM
Orthocladius sp.	31	10.37	6	CG
Pagastia sp.	35	11.71	1	CG
Polypedilum sp.	29	9.70	6	OM
Thienemannimyia Gr.	7	2.34	6	PR
Tvetenia sp.	2	0.67	5	CG
Total Chironomidae	**125**	**41.81**		
Grand Total	**299**	**100.00**		

Aquatic Invertebrate Summary Data

Site Name: Middle Fork Dearborn River | **Site ID: MFD-2 7/11/2000**

TOTAL ABUNDANCE	299
Ephemeroptera + Plecoptera + Trichoptera (EPT) abundance	124
TOTAL NUMBER OF TAXA	32
Number EPT taxa	17

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Misc. Taxa	2	3	1.00
Odonata	0	0	0.00
Ephemeroptera	7	17	5.69
Plecoptera	1	4	1.34
Hemiptera	0	0	0.00
Megaloptera	0	0	0.00
Trichoptera	9	103	34.45
Lepidoptera	0	0	0.00
Coleoptera	2	28	9.36
Diptera	5	19	6.35
Chironomidae	6	125	41.81

RATIOS OF TAX GROUP ABUNDANCES

EPT/Chironomidae	0.99

FUNCTIONAL FEEDING GROUP (FFG) COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	6	15	5.02
Parasite	1	2	0.67
Collector-gatherer	12	110	36.79
Collector-filterer	2	28	9.36
Macrophyte-herbivore	0	0	0.00
Piercer-herbivore	1	34	11.37
Scraper	6	35	11.71
Shredder	1	4	1.34
Xylophage	0	0	0.00
Omnivore	3	71	23.75
Unknown	0	0	0.00

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filterer	1.25
Scraper/(Scraper + C.filterer)	0.56
Shredder/Total organisms	0.00

CONTRIBUTION OF DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Pagastia sp.	35	11.71
Ochrotrichia sp.	34	11.37
Orthocladius sp.	31	10.37
Polypedilum sp.	29	9.70
Hydropsyche sp.	27	9.03
SUBTOTAL 5 DOMINANTS	156	52.17
Brachycentrus americanus	21	7.02
Eukiefferiella Gracei Gr.	21	7.02
Antocha sp.	15	5.02
Optioservus sp.	14	4.68
Zaitzevia sp.	14	4.68
TOTAL DOMINANTS	241	80.60

SAPROBIC INDICES

Hilsenhoff Biotic Index	3.60

DIVERSITY MEASURES

Shannon H (loge)	2.50
Shannon H (log2)	3.61
Evenness	0.72
Simpson D	0.07

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	132	44.15
Univoltine	114	37.96
Semivoltine	54	17.89

	#TAXA	ABUNDANCE	PERCENT
Tolerant	5	66	22.07
Intolerant	0	0	0.00
Clinger	19	186	62.21

Aquatic Invertebrate Taxonomic Data

Site Name: Middle Fork Dearborn River

Site ID: MFD-3 7/11/2000 Approx. percent of sample used: 13

Taxon	Quantity	Percent	HBI	FFG
Physidae	7	2.27	8	CG
Acari	8	2.60	5	PA
Total Misc. Taxa	**15**	**4.87**		
Acentrella turbida	1	0.32	4	CG
Diphetor hageni	1	0.32	5	CG
Attenella margarita	1	0.32	2	CG
Epeorus longimanus	3	0.97	1	SC
Paraleptophlebia sp.	3	0.97	4	CG
Total Ephemeroptera	**9**	**2.92**		
Sweltsa sp.	1	0.32	1	PR
Pteronarcella sp. - early instars	2	0.65	0	OM
Total Plecoptera	**3**	**0.97**		
Amiocentrus aspilus	1	0.32	3	CG
Brachycentrus americanus	2	0.65	1	OM
Ochrotrichia sp.	4	1.30	4	PH
Dicosmoecus gilvipes	1	0.32	2	SC
Total Trichoptera	**8**	**2.60**		
Optioservus sp.	57	18.51	4	SC
Zaitzevia sp.	22	7.14	4	CG
Hydrobius sp.	1	0.32	5	PR
Total Coleoptera	**80**	**25.97**		
Chelifera sp.	1	0.32	6	PR
Simulium sp.	1	0.32	6	CF
Antocha sp.	1	0.32	3	CG
Hexatoma sp.	1	0.32	2	PR
Total Diptera	**4**	**1.30**		
Eukiefferiella Devonica Gr.	1	0.32	4	OM
Eukiefferiella Gracei Gr.	7	2.27	4	OM
Eukiefferiella Pseudomontana Gr.	1	0.32	8	OM
Orthocladius sp.	66	21.43	6	CG
Pagastia sp.	37	12.01	1	CG
Polypedilum sp.	68	22.08	6	OM
Rheocricotopus sp.	2	0.65	6	OM
Rheotanytarsus sp.	1	0.32	6	CF
Thienemannimyia Gr.	5	1.62	6	PR
Tvetenia sp.	1	0.32	5	CG
Total Chironomidae	**189**	**61.36**		
Grand Total	**308**	**100.00**		

Aquatic Invertebrate Summary Data

Site Name: Middle Fork Dearborn River **Site ID: MFD-3 7/11/2000**

TOTAL ABUNDANCE	308
Ephemeroptera + Plecoptera + Trichoptera (EPT) abundance	20
TOTAL NUMBER OF TAXA	30
Number EPT taxa	11

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Misc. Taxa	2	15	4.87
Odonata	0	0	0.00
Ephemeroptera	5	9	2.92
Plecoptera	2	3	0.97
Hemiptera	0	0	0.00
Megaloptera	0	0	0.00
Trichoptera	4	8	2.60
Lepidoptera	0	0	0.00
Coleoptera	3	80	25.97
Diptera	4	4	1.30
Chironomidae	10	189	61.36

RATIOS OF TAX GROUP ABUNDANCES

EPT/Chironomidae	0.11

FUNCTIONAL FEEDING GROUP (FFG) COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Predator	5	9	2.92
Parasite	1	8	2.60
Collector-gatherer	11	141	45.78
Collector-filterer	2	2	0.65
Macrophyte-herbivore	0	0	0.00
Piercer-herbivore	1	4	1.30
Scraper	3	61	19.81
Shredder	0	0	0.00
Xylophage	0	0	0.00
Omnivore	7	83	26.95
Unknown	0	0	0.00

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filterer	30.50
Scraper/(Scraper + C.filterer)	0.97
Shredder/Total organisms	0.00

CONTRIBUTION OF DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Polypedilum sp.	68	22.08
Orthocladius sp.	66	21.43
Optioservus sp.	57	18.51
Pagastia sp.	37	12.01
Zaitzevia sp.	22	7.14
SUBTOTAL 5 DOMINANTS	250	81.17
Acari	8	2.60
Physidae	7	2.27
Eukiefferiella Gracei Gr.	7	2.27
Thienemannimyia Gr.	5	1.62
TOTAL DOMINANTS	277	89.94

SAPROBIC INDICES

Hilsenhoff Biotic Index	4.60

DIVERSITY MEASURES

Shannon H (loge)	1.92
Shannon H (log2)	2.77
Evenness	0.56
Simpson D	0.13

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	154	50.08
Univoltine	69	22.48
Semivoltine	85	27.44

	#TAXA	ABUNDANCE	PERCENT
Tolerant	5	91	29.55
Intolerant	0	0	0.00
Clinger	12	163	52.92

Aquatic Invertebrate Taxonomic Data

Site Name: South Fork Dearborn River

Site ID: SFD-1 7/16/2000 Approx. percent of sample used: 100

Taxon	Quantity	Percent	HBI	FFG
Acari	2	2.20	5	PA
Total Misc. Taxa	**2**	**2.20**		
Drunella coloradensis	1	1.10	0	CG
Serratella tibialis	11	12.09	2	CG
Cinygmula sp.	1	1.10	4	SC
Paraleptophlebia sp.	1	1.10	4	CG
Total Ephemeroptera	**14**	**15.38**		
Sweltsa sp.	2	2.20	1	PR
Zapada Oregonensis Gr.	1	1.10	2	SH
Total Plecoptera	**3**	**3.30**		
Micrasema sp.	1	1.10	1	MH
Ochrotrichia sp.	2	2.20	4	PH
Lepidostoma sp.-turret case larvae	4	4.40	2	SH
Dicosmoecus gilvipes	1	1.10	2	SC
Ecclisomyia sp.	5	5.49	2	OM
Psychoglypha sp.	13	14.29	0	OM
Rhyacophila Brunnea Gr.	1	1.10	1	PR
Neophylax sp.	1	1.10	3	SC
Total Trichoptera	**28**	**30.77**		
Oreodytes sp.	1	1.10	5	PR
Heterlimnius sp.	6	6.59	4	CG
Optioservus sp.	4	4.40	4	SC
Total Coleoptera	**11**	**12.09**		
Pericoma sp.	1	1.10	4	CG
Antocha sp.	2	2.20	3	CG
Total Diptera	**3**	**3.30**		
Cricotopus nostococladius	1	1.10	3	PH
Eukiefferiella Gracei Gr.	1	1.10	4	OM
Micropsectra sp.	3	3.30	7	CG
Orthocladius sp.	15	16.48	6	CG
Pagastia sp.	6	6.59	1	CG
Polypedilum sp.	3	3.30	6	OM
Thienemannimyia Gr.	1	1.10	6	PR
Total Chironomidae	**30**	**32.97**		
Grand Total	**91**	**100.00**		

Aquatic Invertebrate Summary Data

Site Name: South Fork Dearborn River **Site ID: SFD-1 7/16/2000**

TOTAL ABUNDANCE	91
Ephemeroptera + Plecoptera + Trichoptera (EPT) abundance	45
TOTAL NUMBER OF TAXA	27
Number EPT taxa	14

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Misc. Taxa	1	2	2.20
Odonata	0	0	0.00
Ephemeroptera	4	14	15.38
Plecoptera	2	3	3.30
Hemiptera	0	0	0.00
Megaloptera	0	0	0.00
Trichoptera	8	28	30.77
Lepidoptera	0	0	0.00
Coleoptera	3	11	12.09
Diptera	2	3	3.30
Chironomidae	7	30	32.97

RATIOS OF TAX GROUP ABUNDANCES

EPT/Chironomidae	1.50

FUNCTIONAL FEEDING GROUP (FFG) COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Predator	4	5	5.49
Parasite	1	2	2.20
Collector-gatherer	9	46	50.55
Collector-filterer	0	0	0.00
Macrophyte-herbivore	1	1	1.10
Piercer-herbivore	2	3	3.30
Scraper	4	7	7.69
Shredder	2	5	5.49
Xylophage	0	0	0.00
Omnivore	4	22	24.18
Unknown	0	0	0.00

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filterer	#DIV/0!
Scraper/(Scraper + C.filterer)	1.00
Shredder/Total organisms	0.06

CONTRIBUTION OF DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Orthocladius sp.	15	16.48
Psychoglypha sp.	13	14.29
Serratella tibialis	11	12.09
Heterlimnius sp.	6	6.59
Pagastia sp.	6	6.59
SUBTOTAL 5 DOMINANTS	51	56.04
Ecclisomyia sp.	5	5.49
Lepidostoma sp.-turret case lar'	4	4.40
Optioservus sp.	4	4.40
TOTAL DOMINANTS	64	70.33

SAPROBIC INDICES

Hilsenhoff Biotic Index	3.08

DIVERSITY MEASURES

Shannon H (loge)	2.47
Shannon H (log2)	3.56
Evenness	0.75
Simpson D	0.14

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	26	28.57
Univoltine	53	58.24
Semivoltine	12	13.19

	#TAXA	ABUNDANCE	PERCENT
Tolerant	3	7	7.69
Intolerant	2	6	6.59
Clinger	12	38	41.76

Aquatic Invertebrate Taxonomic Data

Site Name: South Fork Dearborn River
Site ID: SFD-4 7/11/2000

Approx. percent of sample used: 15

Taxon	Quantity	Percent	HBI	FFG
Nais sp.	6	1.88	8	CG
Fossaria sp.	25	7.84	6	CG
Physidae	4	1.25	8	CG
Acari	7	2.19	5	PA
Total Misc. Taxa	**42**	**13.17**		
Attenella margarita	7	2.19	2	CG
Drunella coloradensis	2	0.63	0	CG
Nixe sp.	3	0.94	2	SC
Total Ephemeroptera	**12**	**3.76**		
Suwallia sp.	1	0.31	0	PR
Sweltsa sp.	33	10.34	1	PR
Perlodidae-early instar	1	0.31	2	PR
Pteronarcella sp. - early instars	9	2.82	0	OM
Total Plecoptera	**44**	**13.79**		
Brachycentrus americanus	6	1.88	1	OM
Agapetus sp.	17	5.33	0	SC
Ochrotrichia sp.	1	0.31	4	PH
Rhyacophila Brunnea Gr.	1	0.31	1	PR
Total Trichoptera	**25**	**7.84**		
Oreodytes sp.	2	0.63	5	PR
Optioservus sp.	132	41.38	4	SC
Zaitzevia sp.	21	6.58	4	CG
Brychius sp.	4	1.25	5	MH
Total Coleoptera	**159**	**49.84**		
Ceratopogoninae	1	0.31	6	PR
Simulium sp.	4	1.25	6	CF
Antocha sp.	2	0.63	3	CG
Hexatoma sp.	3	0.94	2	PR
Total Diptera	**10**	**3.13**		
Brillia sp.	1	0.31	5	SH
Eukiefferiella Gracei Gr.	4	1.25	4	OM
Micropsectra sp.	1	0.31	7	CG
Pagastia sp.	12	3.76	1	CG
Polypedilum sp.	6	1.88	6	OM
Rheocricotopus sp.	2	0.63	6	OM
Tvetenia sp.	1	0.31	5	CG
Total Chironomidae	**27**	**8.46**		
Grand Total	**319**	**100.00**		

Aquatic Invertebrate Summary Data

Site Name: South Fork Dearborn River Site ID: SFD-4 7/11/2000

TOTAL ABUNDANCE	319
Ephemeroptera + Plecoptera + Trichoptera (EPT) abundance	81
TOTAL NUMBER OF TAXA	30
Number EPT taxa	11

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Misc. Taxa	4	42	13.17
Odonata	0	0	0.00
Ephemeroptera	3	12	3.76
Plecoptera	4	44	13.79
Hemiptera	0	0	0.00
Megaloptera	0	0	0.00
Trichoptera	4	25	7.84
Lepidoptera	0	0	0.00
Coleoptera	4	159	49.84
Diptera	4	10	3.13
Chironomidae	7	27	8.46

RATIOS OF TAX GROUP ABUNDANCES

EPT/Chironomidae	3.00

FUNCTIONAL FEEDING GROUP (FFG) COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Predator	7	42	13.17
Parasite	1	7	2.19
Collector-gatherer	10	81	25.39
Collector-filterer	1	4	1.25
Macrophyte-herbivore	1	4	1.25
Piercer-herbivore	1	1	0.31
Scraper	3	152	47.65
Shredder	1	1	0.31
Xylophage	0	0	0.00
Omnivore	5	27	8.46
Unknown	0	0	0.00

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filterer	38.00
Scraper/(Scraper + C.filterer)	0.97
Shredder/Total organisms	0.00

CONTRIBUTION OF DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Optioservus sp.	132	41.38
Sweltsa sp.	33	10.34
Fossaria sp.	25	7.84
Zaitzevia sp.	21	6.58
Agapetus sp.	17	5.33
SUBTOTAL 5 DOMINANTS	228	71.47
Pagastia sp.	12	3.76
Pteronarcella sp. - early instars	9	2.82
Acari	7	2.19
Attenella margarita	7	2.19
Nais sp.	6	1.88
TOTAL DOMINANTS	269	84.33

SAPROBIC INDICES

Hilsenhoff Biotic Index	3.47

DIVERSITY MEASURES

Shannon H (loge)	1.97
Shannon H (log2)	2.84
Evenness	0.58
Simpson D	0.17

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	28	8.78
Univoltine	117	36.52
Semivoltine	175	54.70

	#TAXA	ABUNDANCE	PERCENT
Tolerant	7	189	59.25
Intolerant	0	0	0.00
Clinger	13	211	66.14